Aug. 20, 1968 YUKIAKI ITO 3,397,663

METHOD FOR REBUILDING THE HULL OF A SHIP TO INCREASE ITS TONNAGE

Filed March 9, 1967 3 Sheets-Sheet 1

FIG. 1

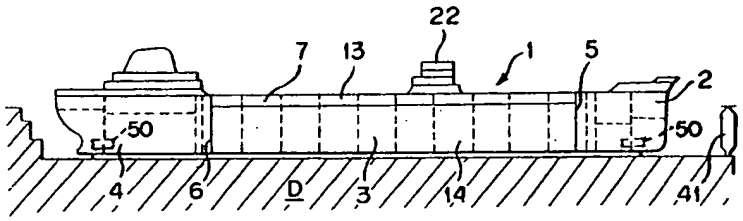

FIG. 2

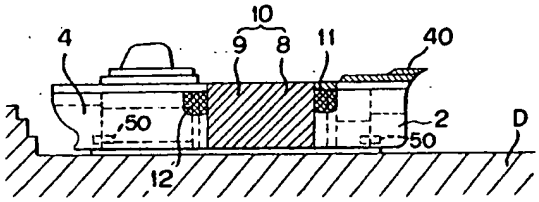

FIG. 3

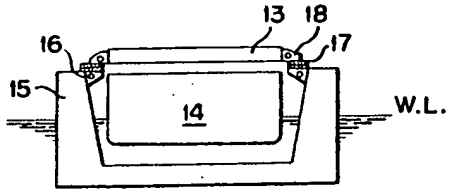

FIG. 4

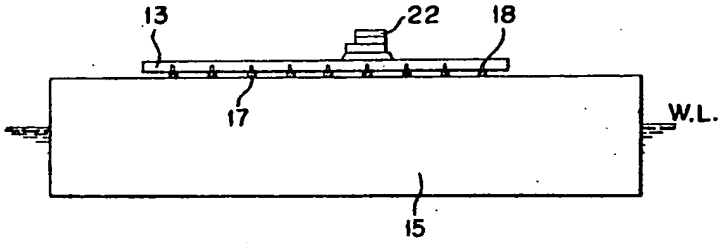

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FIG. 5

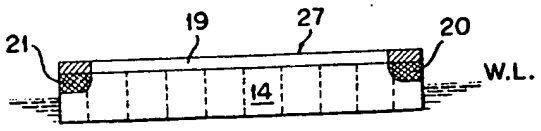


FIG. 6

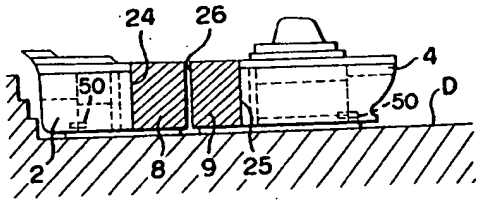


FIG. 7

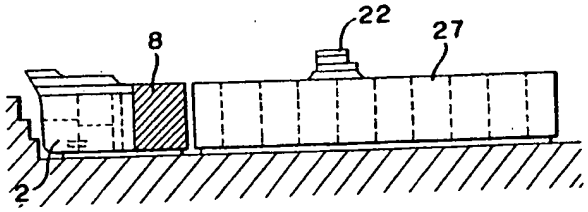
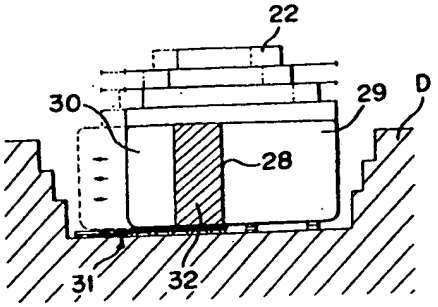


FIG. 8



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Aug. 20, 1968 YUKIAKI ITO 3,397,663
METHOD FOR REBUILDING THE HULL OF A SHIP TO INCREASE ITS TONNAGE
Filed March 9, 1967 3 Sheets-Sheet 3

FIG. 9

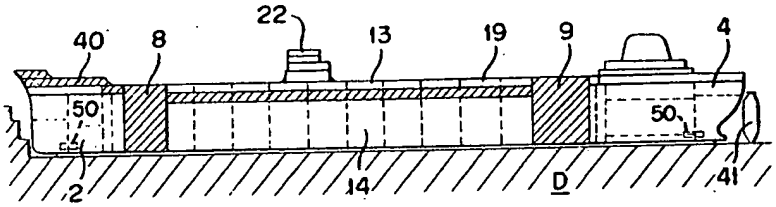


FIG. 10

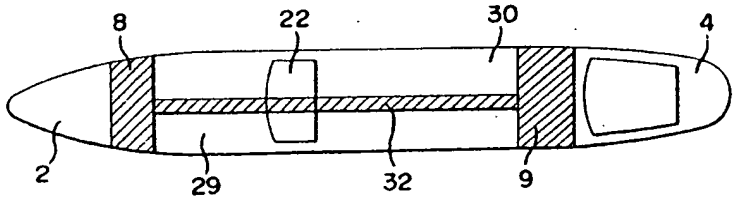
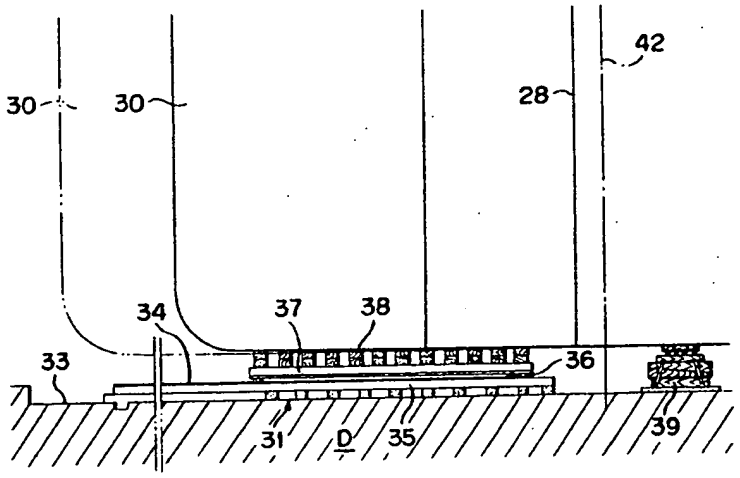


FIG. 11



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United States Patent Office

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METHOD FOR REBUILDING THE HULL OF A SHIP TO INCREASE ITS TONNAGE

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Filed Mar. 9, 1967, Ser. No. 621,932
Claims priority, application Japan, Mar. 16, 1966, 41/15,755
16 Claims. (Cl. 114—77)

ABSTRACT OF THE DISCLOSURE

A method of rebuilding the hull of a ship to increase its tonnage comprising the steps of transversely cutting and dividing the hull into a bow portion, a midships portion and a stern portion and further longitudinally dividing the midship portion into a starboard and a port section. After moving the separated parts either longitudinally or transversely away from one another, new structure is disposed between them and the new and existing sections are joined together to form a hull of increased size and capacity. In cutting the hull, the bow and stern sections are separated from the midship portion in the curved or arched side portions of the hull forward and aft of the parallel portion of the midship part of the hull. In addition to increasing the length or width of the various sections, height or depth is added by inserting new sections into various portions of the hull.

The present invention relates to a new method for rebuilding the hull of a ship to increase its tonnage.

Summary of prior art

In methods of this kind, smaller and less profitable existing ships as compared with recently constructed ships may be rebuilt to increase their size and become more profitable, the following ones have hitherto been known:

(a) Method for lengthening the hull of a ship by transversely cutting its bow and its stern from an approximately parallel middle body thereof, inserting new structures into the spaces thus produced, and joining the new structures to the divided hull parts respectively;
(b) Method for deepening the hull of a ship by cutting off an upper part of the hull part to be deepened from a lower part thereof, inserting a new structure between the lifted upper part and the lower one, and by joining the new structure to the upper and the lower part;
(c) Method for widening the hull of a ship by fixing and joining new structures to both sides of the hull respectively; and
(d) Method, which is called a jumbo one, for substituting a new structure that is much larger either in all dimensions of length, breath and depth or in one or two of the dimensions or a likewise larger structure of another ship for the whole part or a portion of the hull of a ship consisting chiefly of cargo holds.

In such rebuilding, the use of one method alone of the above-mentioned ones seldom occurs but two or three methods are mostly combined as follows:

(e) Combined method for lengthing the hull of a ship as described in (a) and for widening the hull as described in (c);
(f) Combined method for deepening the hull as described in (b) and for wideming the hull as described in (c);
(g) Combined method for deepening the hull as described in (b) and for lengthening the hull as described in (a); and

(h) Combined method for lengthening the hull as described in (a), for deepening the hull as decribed in (b) and for widening the hull as described in (c).

In general, the rate of increase in tonnage (a rate of increased deadweight capacity after rebuilding) of the method (a) is the lowest in those of the above-mentioned methods (a) to (h) due to its relationship with the principal size ratio of the hull of a ship. Those of the methods (c), (b), (e), (g), (f), and (h) increase gradually in this order. On the other hand, the methods (a), (b), (h), and (g) are mostly adopted in view of the relationships of the tonnage increase rate with the construction cost, the loss of speed, and the life of a ship. However, tonnage increases rates of the methods (a) and (b) are lower. Indeed, said rate of the method (d) is higher and the life of a ship rebuilt by said method becomes longer, but the construction cost becomes higher. A tonnage increase rate of the method (g) is also limited. Accordingly, in every case of the previous methods stated above, cost per increased tonnage is higher, as compared with that of a new large-sized ship recently constructed. Furthermore, the effects obtained by the rebuilding for the increase in tonnage are less and therefore the aimed increase in the economic value of a ship cannot be attained.

Summary of the invention

Accordingly, an object of the present invention is to provide a new method for rebuilding the hull of a ship to increase its tonnage, by which a tonnage increase rate not lower than that of the method (d) already described can be obtained. Furthermore, in accordance with the invention, the quantity of steel materials for use in the rebuilding becomes less and the increase in the economic value can be attained.

Another object of the present invention is to provide a new method, in which the widening and the lengthening of the hull of a ship are performed by transversely cutting the hull near the fore and the aft end of the parallel body or midship portion thereof into three separate parts, a bow part, a middle or midship part and a stern part, by moreover longitudinally cutting the midship part, by then transversely moving both portions of the divided middle part in opposite directions to form the space for the widening and by longitudinally moving the bow and the stern part in opposite directions to form the space for lengthening, by furthermore inserting structures for the widening and those for the lengthening the hull into the spaces respectively, and by joining these structures to the divided hull parts respectively.

Still another object of the present invention is to provide a new method, in which the lengthening, the widening and the deepening of the hull of a ship are performed by transversely cutting the hull near the fore and the aft end of the parallel body thereof into three separate parts, a bow part, a middle or midship part and a stern part, by longitudinally dividing the middle part, by inserting and joining a structure for the widening to the divided portions of the middle part, by inserting and joining a structure for the deepening to said portions to form a new middle part, and inserting and joining structures for the lengthening to the bow part, the new middle part and the stern part.

A further object of the present invention is to provide a new method, in which the lengthening of the hull of a ship is performed by transversely cutting the hull, for instance, a little before the fore end of the parallel or midship body thereof and a little behind the aft end of said parallel body into three separate parts, a bow part, a midship part and a stern part, and by inserting and joining new structures to the divided hull parts respectively, and in which the widening of the hull is also per-

formed by longitudinally cutting the midship part into two separate parts and by inserting and joining a new structure to said separate parts.

A still further object of the present invention is to provide a new method, in which the lengthening, the widening and the depending of the hull of a ship are performed by transversely cutting the fore and aft arched part of the hull at respective positions separate from the fore and the aft end of the parallel body thereof into three parts, a bow part, a middle or midship part and a stern part, by longitudinally cutting the middle part into two parts, by inserting and joining new structures to the divided hull parts, respectively, and by fixing a structure for the deepening to the middle part.

It is one of the important objects of the present invention that locations of transverse cuttings of the fore and the aft arched part of the hull are fixed separately from the fore and aft end of the parallel midship body thereof, as will be shown in the drawings. From the description of embodiments of the present invention it will be evident that in the widening step which is characteristic of the method of the present invention transverse cuttings of the hull at such locations have played a significant role in overcoming the difficulties in the fairing work.

Description of the drawings

For a better understanding of the principles of the present invention, reference is made to the following description of typical embodiments thereof illustrated in accompanying drawings, wherein:

FIG. 1 is a side view of the hull of a ship not yet subjected to the rebuilding for increasing its tonnage;

FIG. 2 is a side view of the hull under rebuilding, showing both the removal of a midship part thereof and the union of a structure for the lengthening of the hull with a bow and a stern part;

FIG. 3 is a front view of the midship part to be deepened, showing the separation of its upper part from its lower part in a floating dock;

FIG. 4 is a side view of the midship part shown in FIG. 3;

FIG. 5 is a side view of the midship part to which a structure for the deepening is being fixed on the water;

FIG. 6 is a side view of the hull, showing the cutting of that structure for the lengthening which is inserted between the bow and the stern part and which is joined to them, as shown in FIG. 2;

FIGS. 7 and 8 are side and a front view of the hull respectively, of which the stern part shown in FIG. 6 is carried out of the dock and of which a new middle part is carried therein for widening the hull;

FIG. 9 is a side view of the hull after the tonnage inrease rebuilding, showing its widened parts, its deepened ones and its lengthened ones;

FIG. 10 is a plan of the hull shown in FIG. 9; and

FIG. 11 is a side view of an apparatus for moving a hull part so as to insert a structure for the widening of the hull.

Detailed description of the invention

The method of the invention for rebuilding the hull of a ship for increasing its tonnage will be described following the order of steps. Referring to FIG. 1, the hull of a ship to be rebuilt is first made to enter dry dock D stern first. The dock is then drained, when a caisson gate 41 is closed. In this condition transverse, cuttings of a bow 2 and a stern 4 and longitudinal cutting for the deepening are performed. A cutting line 5 of the bow is on the inward arched sides or part thereof and is separate from the fore end of a parallel middle or midship body, as shown in FIG. 10. Likewise, a cutting line 6 of the stern is on the tapered part thereof and is separate from the aft end of the parallel midship body. On the other hand, the cutting for the deepening is performed along a line 7, which is for instance about 2.50 m. below upper deck in the case of a 40,000 D.W.T. tanker that is 15.01 m. in depth of the hull and is 11.341 m. in draft (designed).

Along these cuttings, the shell plates on a bow fairing portion 11, a stern fairing portion 12, a fore fairing portion 20 and an aft fairing portion 21 in FIG. 5 are removed from the hull. Furthermore, buoyancy tanks 50 are attached to a bow part 2 and also to a stern part 4; bottom transverses of tanks lying at the cutting positions are reinforced inside; the removal of piping on the upper deck and other miscellaneous tasks are performed. The separated bow part 2 and also the separated midship part 3 are carried onto the water while the stern part 4 is left in the dock. On the other hand, a fore structure 8 for the lengthening and also an aft structure 9 for the lengthening are combined beforehand into a structure 10 for the lengthening, as shown in FIG. 2, said structure being made to enter the dock. The bow part 2 is then returned into the dock. The structure 10 for the lengthening is then inserted between the bow part 2 and the stern part 4, which are, in the drained dock, joined to the structure 10 and are faired at the bow fairing portion 11 and also the stern fairing portion 12 respectively. At the same time, an additional portion 40 of a forecastle is joined to the bow part 2 for the enlargement. The hull to which the structure 10 has been joined is then carried onto the water, where the equipment of the joined portions is installed.

The midship part 3 on the water is moored for undergoing preliminary works for increasing its depth. For instance, to the sides of an upper part 13 thereof produced by the cuttings along the line 7 arm members 18 such as brackets are attached. After this attachment, the middle part 3 is made to enter a floating dock 15, as shown in FIGS. 3 and 4.

The floating dock 15 is sunk beforehand to the extent that arm members 18 of the upper part 13 are not brought into contact with supporting means 16 on the dock 15 when the midship part 3 is entering the dock 15. After the docking of the midships part 3, the dock 15 is gradually floated until arm members 18 are engaged with supporting means 16. Thereby, the upper part 13 is supported by the floating dock 15, being separated from a lower part 14, as shown in FIG. 3. The lower part 14 is then carried out of the dock and furthermore a structure 19 in FIG. 5 for increasing its depth is fixed to the lower part which is now moored on the water. At the same time, other tanks than ones situated in the cuttings portion and already subjected to reinforcement are stiffened inside. In attaching the structure 19, shell plates are not provided at its fairing portions because these plates will be attached when the structure for the lengthening is joined. The lower part 14 thus deepened is carried into the floating dock 15, which is then gradually sunk to the extent that the upper part 13 is supported also by the lower part 14. These parts 13, 14 are then joined to each other in the floating dock 15. On the other hand, the hull which has been joined to the structure 10 for the lengthening and which is moored on the water is returned into the dock D at a proper time which is determined by taking into account the progress in the above-mentioned deepening of the midship part. The hull is then subjected to the cutting along a line 26 shown in FIG. 6. Thereby, the bow part 2 provided with the fore structure 8 is separated from the stern part 4 provided with the aft structure 9, said bow part being placed in a fixed position in the dock while said stern part is carried onto the water. Furthermore, the separated portions 26 in FIG. 6 are stiffened so as to have sufficient strength, longitudinally of the hull, to withstand the floating on the water. Furthermore, thinner shell plates are additionally used for these separated portions so that said portions may resist water pressure.

After the carrying away of the stern part 4, a deepened middle part 27 being moored on the water is brought into

the dock and is placed in position by a moving apparatus 31 or the like provided therein, as shown in FIG. 7.

The moving apparatus 31 consists of a base 35 fixed to the bottom 33 of the dock, rails 34 provided on the base, and a sliding table 37 provided with rollers 36 running on rails, as shown in FIG. 11. The hull is supported by the sliding table 37 through supporting members 38 such as blocks. A plurality of moving apparatus 31 are, at a proper longitudinal distance, provided transversely on the bottom of a hull part 29 or 30 to be moved for inserting a structure 32 for widening the midship part. The other part 30 or 29 which is not to be moved is supported by supporting bases 39 such as blocks.

In order to widen the new middle part 27 already placed in position, it is first cut longitudinally along a line 28 which runs a little off the center line of the hull, as shown in FIG. 8. Thereby, the new middle part 27 is divided into two parts, a right-hand or starboard hull part 29 and a left-hand or port hull part 30. The cutting line 28 is, for instance, about 1 m. off the longitudinal center line 42 in the case of the 40,000 D.W.T. tanker the hull of which is 27.43 m. broad. The port hull part 30 (or the starboard hull part 29) is then moved by the moving apparatus 31. Into the space thus produced the structure 32 for the widening is, in proper blocks, inserted by means of cranes. The structure 32 is then joined to the hull parts 29, 30. The widening work is thus finished.

In moving one of the divided hull parts transversely, it may be possible to cut off, instead of moving, a middle bridge 22 from the hull so that said one hull part may be moved on rollers or the like provided between the middle bridge 22 and the hull without it.

After the finishing of the widening work, water is poured into the dock, so that the new middle part 27 is floated and therefore the moving apparatus, blocks, etc., for the widening work can be removed. The bow part 2 however remains to be sunk by pouring water therein or other proper means. The stern part 4 being moored on the water is then brought into the dock and is placed in position together with the new middle part 27.

Next, in the drained dock D, the bow part 2, the new middle part 27 and the stern part 4 are joined one to another by welding and, at the same time, the shell plates and also the fairing blocks for the afore-mentioned fairing portions are fixed. The buoyancy tanks 50 provided on the bow and the stern part are also removed. The widening, the lengthening and the deepening of the hull 1 are thus completed.

As an example of the method of the present invention, the following table is given, in which the principal items in the rebuilding of the 40,000 D.W.T. tanker are indicated:

	Existing	Rebuilt
L_{pp}	206.35 m	245.09 m.
B mold	27.43	35.00.
D mold	15.01	17.525.
d mold	11.341 (designed)	13.70.
D.W.	39,855 l.t.	About 75,000 l.t.
G.T.	24,906.35 t.	About 42,200 t.
Cargo Capacity (100%, m.³)	53,185.4	About 92,800.

NOTE.—Fore Structure for the Lengthening, Weight about 900 t. Aft Structure for the Lengthening, Weight about 1,100 t.

Now, another embodiment of the present invention will be described. In this case, the hull to be rebuilt for increasing its tonnage is made to enter a dock, which is then drained after the closing its caisson gate. The hull is then cut transversely near the fore and the aft end of a parallel midship body, being divided into three parts, a bow part, a midship part and a stern part. The bow and the stern part are longitudinally moved in opposite directions to form the space for the lengthening. In moving these parts, the afore-mentioned moving apparatus may favorably be used. The midship part is then cut along a line so as to be deepened. In the deepening work, water is poured into the dock. The bow and the stern part however remain submerged by pouring water therein or other proper means. Accordingly, the midship part alone is floated to the extent that an upper part thereof produced by cutting becomes higher than shoulders of the dock. The dock is then drained, when the upper part is supported both by arm members such as brackets provided on the sides of the upper part and by supporting means provided on the insides of the dock for receiving these arm members. Thereby, a lower part of the middle part is separated from the upper part, the space for the deepening being thus formed. A structure for the deepening is, in proper blocks, inserted into the space, being joined to the lower part. Water is again poured into the dock to the extent that the lower part to which the structure has been joined can support the upper part. The arm members as well as the supporting means are then removed. The dock is again drained, when the upper part is joined to the lower part placed in position. The deepening work is thus finished.

In the above-mentioned case, the number of tools and materials necessary for cutting and joining of the upper part are limited to the least possible. Cranes are carrying the upper part are not used. Furthermore, natural force due to the difference between a flood and an ebb tide is effectively used. Accordingly, the use of a dock for the deepening work is very favorable.

In a varied embodiment, however, the upper part is by cuttings divided into larger blocks, and besides a plurality of arms for receiving jacks are fixed on upper deck in the longitudinal direction while guide posts containing jacks are provided on the lower part. These posts are engaged with the arms respectively, so that if the upper part is jacked up and the arms are held at predetermined positions within the guide posts, then the space for the deepening is formed. A structure for the deepening is then inserted into the space, being joined to the two parts.

The middle part of the hull thus deepened is then cut longitudinally into two parts, which are transversely moved by the afore-mentioned moving apparatus in opposite directions so as to form the space for the widening. Although, in the case already described, the cutting line is a little off the center line, yet it is also possible to cut at positions occupied by wing tanks provided at both sides.

A structure for the widening is then inserted into the space stated above by cranes or other proper means, said structure being joined to the divided parts of the midship part.

Structures for the lengthening are then inserted into the space provided between the bow part and the midship part already deepened and widened and are also inserted into the space provided between said midship part and the stern part, said structure being joined to the divided parts. On the other hand, fairing blocks, shell plates, etc. are fixed to the portions that have remained without shell plates. The lengthening work is thus finished.

In the step of the rebuilding work illustrated in FIG. 2, a modification may be performed. Although the fore structure 8 is combined beforehand with the aft structure 9 to form the combined structure 10 which is inserted and joined to the divided parts of the bow and the stern part, the hull thus formed being then cut along the line 26 shown in FIG. 6 into two parts so that the midship part may be inserted between said two parts and may be joined to them, yet the fore structure 8 may be constructed separately from the aft structure 9 and the two structures may be joined to the low and the stern part respectively in the dock.

Besides, the attachment, of the divided hull parts may, if necessary, be favorably performed on the water, though in the above-mentioned embodiments the joining of the hull parts is carried out in the drained dock. For in-

stance, a method of joining on the water is in detail described in the United States patent application No. 602,880 by the applicant in the present application. Furthermore, a method of joining, by underwater welding performed by divers, the underwater portions of both hull parts firmly held by proper means, a method of joining the underwater portions of the hull parts by welding after the discharge of water by pumps from caissons or waterproof boxes watertightly covering the outsides of said portions, etc., are referred to.

As is evident from the foregoing description, in accordance with the method of the present invention the hull of a ship to be rebuilt for the increase in tonnage is, in a drained dock, cut transversely near the fore and the aft end of the parallel part thereof into three parts, a bow part, a midship part and a stern part, said midship part being, furthermore, longitudinally divided into two parts which are transversely moved in opposite directions so that the space for the widening may be produced, while said bow and said stern part are longitudinally moved in opposite directions so that the space for the lengthening may be produced, the structure for widening and lengthening the hull are inserted into these spaces respectively, said structures being joined to the divided hull parts respectively. Consequently, higher rate of the increase in tonnage is obtained without any difficulty. Especially, the quantity of steel materials for use in the rebuilding works is less. Thus, the increase in the economic value of a rebuilt ship can effectively be attained.

It is to be understood that various modifications of the disclosed embodiment may be made without departing from the spirit and scope of the present invention as set forth in the appended claims.

What is claimed is:

1. A method of rebuilding the hull of a ship to increase its tonnage comprising the steps of: transversely cutting and separating the hull into a bow portion, a midship portion and a stern portion, longitudinally cutting and separating the midship portion into a starboard section and a port section, moving the separated bow and stern portions in the longitudinal direction of the hull away from the midship portion, moving the separated starboard and port sections in the transverse direction of the hull away from one another, inserting a new transverse section between the separated bow and midship portion and between the separate separated stern and midship portion, inserting a new longitudinal section between the separated starboard and port sections of said midships portion, and joining the new transverse and longitudinal sections to the existing hull portions and sections for increasing the tonnage capacity of the hull.

2. A method of rebuilding the hull of a ship as set forth in claim 1, comprising the step of cutting the bow portion and the stern portion of the hull near the midship portion of the hull.

3. A method of rebuilding the hull of a ship as set forth in claim 1, comprising the step of cutting the bow portion and the stern portion of the hull in the curved side portions of the hull forward and aft of the midship portion having parallel side portions.

4. A method of rebuilding the hull of a ship as set forth in claim 2, comprising the step of longitudinally cutting the midship portion into an upper and a lower section and inserting a new section between the upper and lower section for increasing the height of the midship portion.

5. A method of rebuilding the hull of a ship as set forth in claim 2, comprising the step of adding a new section to the top of said bow portion of said hull for increasing the capacity of the bow portion.

6. A method of rebuilding the hull of a ship as set forth in claim 2, comprising the steps of removing a part of the hull surface on the bow portion, the midship portion and the stern portion in the area adjacent the cutting plane between the bow portion and midship portion and between the stern portion and the midship portion, and after the new sections of the hull have been inserted between the bow portion, midship portion and the stern portion replacing the surface of the hull portions and fairing the replaced surfaces to meet the existing surfaces of the new portions placed in the hull.

7. A method of rebuilding the hull of a ship as set forth in claim 1, comprising the step of floating the hull to be rebuilt into a dry dock and draining the dry dock.

8. A method of rebuilding the hull of ship as set forth in claim 7, comprising the step of adding buoyancy tanks to the bow portion and stern portion of the hull.

9. A method of rebuilding the hull of a ship as set forth in claim 8, comprising the steps of removing the separated bow portion and midship portion of the hull from the dry dock, placing the bow portion of the hull back into the dry dock, inserting a new transverse section between the separated bow and stern portions of the hull, and joining the bow portion and the stern portion to the new transverse section.

10. A method of rebuilding the hull of a ship as set forth in claim 9, comprising the step of fairing the surface of the existing bow portion and stern portion to the new transverse section inserted therebetween.

11. A method of rebuilding the hull of a ship as set forth in claim 2, comprising the steps of placing the midship portion of the hull in a floating dock, supporting the upper portion of the midship portion from the floating dock, cutting the midship portion to provide an upper portion supported by the floating dock and a lower portion floating within the dock, adding a new height portion on the lower portion of said midship portion, and joining the new height portion of the midship portion to the upper portion thereof thereby increasing the height of the midship portion.

12. A method of rebuilding the hull of a ship as set forth in claim 9, comprising the steps of cutting the new transverse section to provide a bow section and stern section each having attached thereto a part of the new transverse section, removing the stern portion of the hull from said dry dock, placing the midship portion of the hull into the dry dock, longitudinally cutting the midship portion into a starboard section and a port section, moving the port section and starboard section away from one another, inserting a new longitudinal section between the separated port and starboard sections of said midship portion, and joining said starboard section and port section to the new longitudinal section disposed therebetween.

13. A method of rebuilding the hull of a ship as set forth in claim 12, comprising the steps of inserting the stern portion of the hull into the dry dock, and attaching the bow portion and its new transverse section to the widened midship portion of the hull and similarly attaching the stern portion and its new transverse section to the aft portion of the widened midship portion of the hull.

14. A method of rebuilding the hull of a ship as set forth in claim 13, comprising the steps of removing the buoyancy tanks from the stern portion and bow portion of the hull, and fairing the midship portion to the new sections.

15. A method of rebuilding the hull of a ship as set forth in claim 1, comprising the steps of floating the hull into a dry dock, supporting the upper portion of the hull from the top of the dry dock, cutting the upper part of the midship portion of the hull from the lower part thereof, separating the upper part and lower part of the midship portion, inserting a new section therebetween for increasing the height of the midship portion, and joining the new section to the lower part and upper

part of the midship portion of the hull for increasing the depth of the midship portion.

16. A method of rebuilding the hull of a ship as set forth in claim 15, comprising the steps of moving the upper part of the midship portion upwardly for inserting between the upper part and the lower part of said midship portion of the hull said new section for increasing the depth of the midship portion.

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